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THE UTILITY OF HYPERSPECTRAL DATA TO DETECT AND DISCRIMINATE ACTUAL AND DECOY TARGET VEHICLES

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The objective of this work is to evaluate the utility of hyperspectral signature data in satisfying time-sensitive intelligence requirements. This work is conducted in support of the Hyperspectral MASINT Support to Military Operations (HYMSMO) program. Data are used from the Hyperspectral Digital Imaging Collection Experiment (HYDICE) imaging spectrometer using the 0.4 μm to 2.5 μm wavelength range. Operation Forest Radiance I was the third in a series of HYMSMO-sponsored collection and exploitation experiments, and the data set analyzed herein was derived from this effort. The first phase of the Forest Radiance experiment emphasized the collection of spectra from a suite of overtly exposed mobile vehicles, decoys, and target panels. Analysis shown here was conducted to determine if it is possible to detect and discriminate real and decoy vehicles. The Low Probability of Detection (LPD) and Spectral Angle Mapper (SAM) anomaly detection and classification algorithms are applied to the data set being analyzed. The LPD algorithm performs well at detecting residual spectra, but produces a significant number of false alarms. The SAM technique is equally successful at detecting residual spectra and proves to have an advantage over the LPD when it comes to obviating misidentifications. This thesis shows that detection and discrimination of mobile vehicles (HMMWVs) and decoys in a natural grass environment is possible using this technology.

JOINT DEPLOYABLE INTELLIGENCE SUPPORT SYSTEM (JDISS) COMMUNICATIONS AND IMAGERY APPLICATION GUIDE FOR NEW USERS

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The purpose of this thesis is to provide a Joint Deployable Intelligence Support System (JDISS) Communication and Imagery Application Guide for New Users. These two applications, together, are the core of the JDISS program. Both applications were examined to identify functions and processes that are difficult to understand as well as functions and processes that lack sufficient instructions for new users. The supporting JDISS Desktop and Utilities applications were added to provide the knowledge base required for the new user to use the Application Guide as a stand-alone document. Other JDISS applications, such as Office Tools, Email, Intelink, etc., are not included due, in part, to a common thread with other programs that the new user should already be familiar with, but mostly due to the adequate help instructions readily available within the JDISS main desktop help function.

The JDISS program was developed to ensure that each of the U.S. Services and Agencies had an integrated intelligence system, and one that would provide a common data standard permitting interoperability both intra-service and inter-service. The Joint Staff, Director of Intelligence (J2), has highlighted JDISS in joint doctrine as the principal intelligence component

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for interoperability (JBOC, 1996). Therefore, this detailed, step-by-step JDISS Communication and Imagery Application Guide for New Users was developed and designed to help future JDISS users worldwide.

THE INTEGRATION OF SITUATIONAL AWARENESS BEACON WITH REPLY (SABER) WITH THE ENHANCED POSITION LOCATION REPORTING SYSTEM (EPLRS)

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In 1992, the Joint Requirements Oversight Council validated a combat identification mission need statement. In support of the requirement for system interoperability, this thesis proposes a concept of operations for integrating two systems, Situational Awareness Beacon with Reply (SABER) and the Enhanced Position Location Reporting System (EPLRS).

SABER is a program initiated by Naval Space Command to provide real-time combat identification (CID) to the tactical user. It uses UHF satellite communications technology in conjunction with the Global Positioning System (GPS) to provide positioning information for up to 500 users.

EPLRS is a situational awareness program used extensively by the U.S. Army to support tactical battlefield operations. In addition to providing automatic friendly identification of EPLRS-equipped units, it has a communications capability that allows for the passage of intelligence and targeting data, messages, and status reports. However, EPLRS operates in a line-of-sight mode only and uses military grid reference coordinates vice GPS for positional information.

The integration of SABER and EPLRS has the potential to serve a major role in the armed services' common goal of reduced fratricide. This thesis gives a detailed description of both systems, examines their individual capabilities and limitations, discusses the ways in which the two systems complement each other, and provides a recommended integrated concept of operations.

COBRA BRASS FOR BATTLESPACE CHARACTERIZATION AND BATTLE DAMAGE ASSESSMENT (U)

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Battlespace characterization and battle damage assessment are important to the warfighter and must be a part of the strike planning. The Cobra Brass research and development sensor has the capability to provide information the warfighter can use to aid in his decision making. Navy TENCAP is using Cobra Brass in an operational mode to test the feasibility of operationally tasking this type of sensor. This thesis educates the warfighter on the Cobra Brass family of sensors, investigates the utility of Cobra Brass for battlespace characterization and battle damage assessment, and develops a concept of operations for the non-imaging infrared sensors presently deployed and for future such sensors.

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DESIGN AND DEVELOPMENT OF THE SCENARIO FOR THE SECOND NPS A2C2 EXPERIMENT

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The Adaptive Architectures for Command and Control (A2C2) project is a research effort sponsored by the Office of Naval Research to explore adaptation in command and control structures. The project's second experiment builds on the first experiment. It studies the interaction between task structure and organization structure. This thesis builds on the work of previous theses by Michael Bergin and Scott Higgins. It describes a process for developing military operational scenarios within a task structure context. First, the author conducts a literature review, which defines the dimensions of task structure applicable to this project, and describes how changes in one dimension might affect other dimensions. Then a method for developing scenarios in accordance with a predetermined structure and visualizing tasks is described, including a task structure diagram and a description of a task design process using the diagram and the dimensions previously delineated. The author then applies the task design process by developing two scenarios for the second NPS A2C2 experiment that differ across one dimension of task structure, coordination requirements. Finally, a description of the experiment is given, including discussion of operationalization of scenarios and organization structures, and lessons learned from the experiment with regard to scenario design.

COMMUNICATION MODULATION SIMULATORS: AN ASSESSMENT

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The military drawdown and budget cutbacks have created a greater emphasis on shorter, faster, and cheaper ways to do the mission. Modulation simulators have become a critical component in the evaluation and testing, and integration of new network, communications, and command and control technologies and applications.

This thesis evaluates five current commercial-off-the-shelf products: OPNET Modeler by MIL 3 Inc.; COMNET III designed by CACI Products Company; Extend by Imagine That Inc.; Workbench created by Scientific Engineering Software Inc.; and G2 from the Gensym Corporation. Each of the products is evaluated using twenty-five primary evaluation criteria. The evaluations include current costs, completeness, user interface, and post analysis support methods, and they describe the basic features and distinctive characteristics of each product.

The capabilities of the products are compared, providing the reader with the knowledge to make an informed product selection based on the user's needs. A matrix of the products and the evaluation criteria provides a quick overview of the analysis.

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AN EFFECTIVENESS STUDY FOR PRIORITIZATION ALGORITHMS IN A COMMUNICATIONS NODE MODEL FOR THE COPERNICUS TACTICAL DATA INFORMATION EXCHANGE SYSTEMS (TADIXS)

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The U.S. Navy has published its vision of the future in Command, Control, Communications, Computers and Intelligence (C4I): Copernicus. Copernicus takes advantage of new technology and attempts to answer the demand for larger amounts of more timely information. Despite the advances in technology, new transmission methods and increased bandwidth, the U.S. Navy still does not have all the communications throughput that it desires. The author examines message prioritization algorithms as a way of making more efficient use of scarce communications resources. Through a simple communication node model and two algorithms, it is statistically proven that prioritization algorithms can improve the efficiency of a communication system.

THE ARMY TACTICAL COMMAND AND CONTROL SYSTEM

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This thesis is a summary of the capabilities of the Army Tactical Command and Control System (ATCCS) and the guiding Command, Control, Communications, Computers and Intelligence (C4I) documents as they apply to the ATCCS. Its purpose is to strengthen the knowledge base of Army officers entering the Joint C4I curriculum by providing a summary of Joint and Army C4 doctrine and guidance as it applies to ATCCS.

ATCCS is the Army's primary Command and Control (C2) system at echelons corps and below. ATCCS consists of five smaller systems, each a Battlefield Functional Area Control System (BFACS) controlling seven Battlefield Functional Areas (BFA). The five BFACS are the Maneuver Control System (MCS), the Advanced Field Artillery Tactical Data System (AFATDS), the Forward Area Air Defense Command, Control and Intelligence System (FAAD C21), the Combat Service Support Control System (CSSCS), and the All Source Analysis System (ASAS).

A clear strategy for the functional design of ATCCS is supported by three documents. Related to and supportive of each other, the three documents are Joint Pub 6-0, Doctrine for Command, Control, Communications and Computer Systems Support to Joint Operations; The Army Enterprise Strategy consisting of The Vision and The Implementation Plan; and Army Field Manual 100-5, Operations. This thesis draws threads of continuity from joint doctrine through Army guidance into implementation in ATCCS.

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A STUDY OF NATIONAL RECONNAISSANCE OFFICE'S (NRO) FUTURE COMMUNICATIONS ARCHITECTURE (U)

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The National Reconnaissance Office (NRO) has identified much higher data rate requirements for future national systems. The goal of this thesis is to provide a possible alternate solution that would utilize crosslink technology developed for the Iridium Mobile Satellite System combined with existing and emerging laser communications technology. In addition to many other advantages over RF communications, laser communications can fulfill the extremely high data requirements of the future NRO systems. This technology could be a part of a new satellite constellation that can provide single and double global coverage in Stage I and Stage II, respectfully, of the satellite constellation design.

MULTIATTRIBUTE UTILITY ANALYSIS OF NON-SATELLITE COMMUNICATIONS (U)

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There is a growing awareness of U.S. overhead reconnaissance capabilities throughout the world today. In the last twenty years various entities have revealed portions of the U.S. overhead coverage and capability. Operation Desert Shield/Desert Storm served to underscore both the U.S. reliance on overhead collection and the robustness of this architecture. Additionally, there has been an effort to downgrade the classification of overhead intelligence products. While this provides additional intelligence to U.S. forces, allies, and coalition partners, it also provides a greater understanding of previously sensitive national programs to a wider audience.

Today there are many countries who have or are developing denial and deception programs. These countries may easily obtain information about U.S. overhead capabilities through a variety of means. Some countries may exploit overhead system vulnerabilities in order to enhance their own denial and deception programs.

With multiattribute utility analysis, a model was created with which one can evaluate overhead systems designed to thwart foreign exploitation. Through this model one way will be demonstrated in which U.S. overhead security may be maintained while still providing broad support to U.S. forces.

DIRECT BROADCAST TECHNOLOGY IN BOSNIA: ITS IMPACT ON THE DECISION-MAKING PROCESS AND JOINT ENDEAVOR OPERATIONS

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During Desert Storm a serious shortfall was identified in the communications architecture and its ability to effectively provide high-bandwidth information to meet the demands of the operation. In response to this shortfall, the Department of Defense (DoD) is pursuing the exploitation of commercial Direct Broadcast Satellite (DBS) technology and its ability to

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broadcast video and data at high rates to small, affordable, and portable terminals. The Global Broadcast Service (GBS) was initiated to ultimately provide this military direct broadcast capability.

A precursor to GBS, the Joint Broadcast Service (JBS), was begun as an Advanced Concept Technology Demonstration (ACTD). It is now leveraging DBS technology to support Operation Joint Endeavor. This thesis describes how the JBS works, what types of information are sent over the JBS, the complete process of information distribution, and the impact the JBS has had on Operation Joint Endeavor and the associated operational decision making process.

The JBS system has, at least in part, answered the joint warfighter's need for an improved high-bandwidth video and data distribution system. Although it does have force enhancement capabilities, the lack of familiarity, information management, and trust of the system have limited its effectiveness in Operation Joint Endeavor.

REQUIRED INFORMATION SYSTEMS KNOWLEDGE FOR NAVAL INTELLIGENCE OFFICERS

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To be effective in most current billets, Naval Intelligence Officers must have a baseline technical knowledge of computer hardware and software, data communications, and related-systems (known collectively as Information Technology). This thesis reviews survey data of common Intelligence Officer billets ashore and afloat as well as leadership statements and doctrine. Using these sources, knowledge requirements of existing and future Intelligence Officer assignments are identified in this study, and it is clear that these requirements are not currently being satisfied through standard intelligence training methods. An outline is provided of information technology fundamentals, military and commercial telecommunications, intelligence systems, applications, and connectivity to assist with formal or self-training programs.

Intelligence Officer training and education must include more information technology and intelligence architecture. Existing intelligence courses and other non-traditional programs should be better utilized by Naval Intelligence personnel. ONI or DIA should ensure that these programs are both current and readily available to Intelligence Officers throughout their entire careers.

ISSUES IN SPACE LAW AND POLICY

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This thesis provides a student studying space with background information and insight into selected issues that have shaped, or continue to shape, the world's approach to activities involving space. Further, the basic understanding gained through the study of these issues and their connection with international treaties and policies gives an appreciation for the regulatory side of space programs.

Some of the topics discussed are the delimitation and control of space, space debris, and the interpretation of the Anti-Ballistic Missile Treaty. Though they are often seen as issues in space law, it is shown that political considerations and decisions more often determine the outcome or path followed. Further, technical aspects and applications have seemingly usurped any laws which govern use, i.e., what can or cannot be done. Regardless, a commitment to the future use of space is as important as current operations.

This does not imply a need to quickly fill this legal void with well-meaning rules to provide structure. Rather, it is seen that certain laws do need to be created in order to ensure the continued access and use of space will not be interrupted.

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ANALYSIS OF HYPERSPECTRAL DATA USING POLARIMETRIC CHARACTERISTICS

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The utility of polarimetric reflectance characteristics of targets and background surfaces in the analysis of hyperspectral imagery data is investigated. A technique is proposed for filtering a data hypercube of an imaged scene to select targets for subsequent analysis using standard hyperspectral signature matching techniques, thereby reducing image analysis time. An experimental study to measure polarization characteristics of reflected light from various surfaces in order to determine wavelengths for maximum and minimum intensity differences between polarized reflectance values is proposed. A second study is outlined for collection of simulated hyperspectral imagery that would attempt to validate the proposed filtering technique. A research of past studies indicate that useful polarization signature components are present for many targets and target materials. Additionally, backgrounds composed of grass, trees, dirt, and clouds generate very little polarized components making detection of targets using polarization signatures feasible.

EXPECTED PERFORMANCE OF THE GLOBAL BROADCAST SERVICE, (GBS) PHASE II, WITH EMPHASIS ON ENVIRONMENTAL LIMITATIONS TO SUPPORTABLE DATA RATES

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The U.S. military requires a high capacity, high availability broadcast capability to provide timely dissemination of standard products to users who cannot rely on terrestrial links. The Global Broadcast Service (GBS) is being developed to meet this requirement. The key limiting factor in GBS availability is environmental losses, specifically atmospheric absorption and rainfall loss. The optimum frequency band for GBS would have been between 1-10 GHz. At this frequency range, environmental losses are negligible. However, congestion in this frequency range has forced DoD to choose a much higher frequency band for GBS, 20/30 GHz (K/Ka band). At this frequency band environmental losses, specifically rain loss, will be a key limiting factor to GBS availability. This thesis analyzes GBS Phase II performance taking into account atmospheric limitations. A key problem in determining the performance of GBS lies in the accuracy of existing rain loss models. Several rain loss prediction models were considered, and based on studies conducted by the ITU-R and Stanford Telecom, the USA rain model was chosen for this analysis. This thesis has shown that, due to environmental losses, high availability can best be achieved if GBS is capable of lowering its data rate during periods of precipitation.

USSOCOM METRICS – A CASE STUDY IN MODERN C4I NETWORK MANAGEMENT ISSUES

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Modern Department of Defense C4I systems utilize high speed commercial computer networks, composed of commercial equipment and connectivity. The United States Special Operations Command (USSOCOM's) SCAMPI (not an acronym) Network was a forerunner of this trend. Industry uses the same type of circuits but approaches the network management of

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these circuits from a financial interest versus the military strategic and tactical aspects considered by the service user. This thesis analyzes this representative network in the context of industry network management and metrics practices. The thesis first surveys and explains the industry practices most prevalent in this changing environment and then examines the practices in place at USSOCOM. The compilation of industry-wide network management and metrics procedures is followed by a series of solution recommendations for the SCAMPI network. These recommendations are explained in the context of current industry practices. This is followed by a series of emerging industry trends and technical developments which most likely will affect the implementation of network management and metrics tools. These developments are followed by a comprehensive industry definitions section, network bibliography, and a hypertext link guide to current military, industry and educational institutions networking solutions.

CONCEPT OF OPERATIONS FOR RADIANT CRYSTAL

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The increased demand for mobile communications worldwide has led to a proliferation of mobile satellite communications systems. While cellular technology and smaller low earth orbit (LEO) communications satellite systems grow in popularity, they do not always provide the regional coverage offered by geostationary communications satellites. This thesis examines nonmilitary mobile satellite communications system and discusses parameters subject to exploitation. Exploitation techniques will be described in detail, followed by an overview of Radiant Crystal, a prototype system developed by Naval Command, Control, and Ocean Surveillance Center (NCCOSC) Research, Development, Test and Evaluation Division (NRaD) in San Diego, California. Finally, the employment of Radiant Crystal in a tactical environment, including an overview of the threat, possible collection site locations, collection site operations and data dissemination, will be examined.

